

# User Guide

**Model-based estimates of households in poverty for  
Middle Layer Super Output Areas in England and  
Wales, 2007/08**

**November 2010**

**Methodology Directorate, and  
Centre for Regional and Local Statistics**



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## 1 Introduction and Background

### 1.1 Introduction

This report provides users with guidance as to the use of these estimates. The second section of this report discusses the use of the estimates, the limitations of the data and how to overcome these. The third section presents a brief technical description of the methodology used to produce the model based estimates. This gives users an appreciation of how the estimates are created and further information on their strengths and limitations. Section 4 displays maps of Middle-Layer Super Output Area (MSOA) level estimates for England and Wales as an example of the spatial differences within the data.

### 1.2 Background

Income information is needed at the small area level in order to help identify deprived and disadvantaged communities and to support work on social exclusion. This requirement was previously reflected by Census User Groups who made a strong case for a question on income to be incorporated in both the 2001 and 2011 Censuses. Although this need was recognised by the government, concerns were also expressed about the sensitivity of an income question, potential impacts on response rates and data privacy issues. As a result, a question on income has not been included in these Censuses. Instead, alternative methods for obtaining data on income at the small area level were identified and implemented leading to the use of small area estimation methodologies to produce local area income estimates.

ONS has published household mean income model based estimates at MSOA level based on data from the Family Resources Survey (FRS) and Households Below Average Income (HBAI) statistics for 2007/08 and 2004/05 following previous publication at ward level in 1998/99 and 2001/02. Four measures of mean income have been published each time – household total gross income, household net income, equivalised household income before housing costs and equivalised household income after housing costs.

Users (who have welcomed the publication of model based estimates of mean income) have also expressed the need for estimates of more specific poverty measures, such as the HBAI indicator of those below 60 per cent UK median household weekly income, and preferably on a basis of persons or children. There are two such measures of poverty currently used by the Department for Work and Pensions (DWP), one with respect to income before housing costs are taken into consideration, the other after housing costs. These are referred to as BHC and AHC respectively. These statistics are not available at local area level. DWP strongly support the request from users for producing small area poverty estimates.

ONS Methodology Directorate has investigated the possibility of generating such estimates. The analysis is based on proportions of households (rather than persons or households of a particular type) as the modelling more naturally integrates with the methodology developed for the mean estimation of the continuous quantity of household income itself.

A project was set up to produce 2007/08 MSOA-level estimates of the proportion of households in poverty for England and Wales, calculated based on equivalised household income after housing costs and produced using the small areas estimation project (SAEP) methodology. This is the same methodology that was used to produce mean income estimates (Longhurst *et al*, 2004 and 2005). The underlying small area estimation model uses unit level survey responses but area level covariates due to the difficulty of linking unit level survey, Census and administrative data sources.

## 2. Guidance on Use

### 2.1 Model-based approach

A model based approach is based upon determining a relationship between proportion of households whose net weekly income (after housing costs) is below the poverty value and covariate information (primarily from Census or administrative sources) for the MSOAs that are represented in the survey. The poverty value is defined as 60 per cent of UK median weekly income which for 2007/08 is £199 as reported in the 2007/08 HBAI Report. This relationship is then used to provide estimates of proportion of the households below this poverty line for all MSOAs. A brief explanation of the methodology is provided in Section 3. The reader interested in further detail is referred to the associated Technical Report. This report also discusses work carried out on a model for households in poverty based on income before housing costs which was found to be of insufficient quality for publication.

To ensure that the model based estimates are consistent with the HBAI published estimates at higher geographical levels, the model-based estimates are constrained to the direct estimates at Government Office Regions (GORs) in England and the estimate for the country of Wales.

### 2.2 Guidance on use and limitations of the estimates

The main limitation of estimates for small areas, either those estimated directly from responses to surveys or model-based, is that they are subject to variability (see Section 3). ONS has produced confidence intervals associated with the model-based estimates for each MSOA in order to make the precision of the estimates clear (see Section 3.6 for further information).

Four further limitations of the estimates must be considered:

- the consistency and accuracy of poverty estimates in relation to those for other, often larger geographical areas
- the conclusions that may be drawn from the estimates on the overall distribution of poverty and the ranking of specific areas
- consistency between different time periods
- comparability with previous estimates

## 2.2.1 Consistency and accuracy of estimates for other geographical areas

The model-based methodology produces MSOA-level estimates of the proportion of households with equivalised income below £199 per week. These MSOA level estimates can be aggregated to provide poverty estimates for larger geographical areas such as local authority level or regions. However, the model based estimates for different MSOAs are correlated because they are obtained from a single model in which the set of regression coefficients is estimated using data from all MSOAs.

Therefore, to make comparisons between broader areas, the standard error of the aggregated estimate has to incorporate not only the variability of each estimate but also the correlation between estimates. Currently, ONS does not have estimates of the required correlations. Hence it is not possible to assess the precision of the aggregated estimates though this issue will be considered in future work.

The model-based methodology has been developed to ensure that the MSOA estimates are constrained to direct survey estimates from the HBAI for GORs in England and the estimate for the country of Wales. For example, the model-based estimates for the MSOAs in Wales when aggregated correspond to the HBAI estimate of the proportion of households in poverty for Wales. However, the model-based estimates will not be consistent with HBAI estimates of proportion of households in poverty for other geographies.

## 2.2.2 Distribution and ranking of poverty levels

In common with any ranking procedure based on estimates, when ordering MSOAs by poverty level, care must be exercised in interpreting these ranks. One needs to take into account the variability of the estimates when using these figures. For example, the confidence interval around the lowest ranked MSOA (lowest level of poverty) suggests that the estimate lies among the **group** of MSOAs with the lowest poverty levels rather than being the MSOA with the very lowest poverty level.

Once again, in order to compare model-based estimates of two particular MSOAs it would be necessary to account for the correlation of the estimates. Nonoverlapping confidence intervals may be taken as an indication that the MSOA estimates are statistically different. However, this evidence must be used with caution as this constitutes a naive procedure to account for the uncertainty when estimating the difference between two cross-sectional estimates.

Although these model based estimates can be used to rank MSOAs by proportion of households in poverty, they cannot be used to make any inferences on the distribution of poverty across the MSOAs. The estimation procedure tends to shrink estimates towards the average level of poverty for the whole population, so model-based estimates at each end of the scale tend to be over or under-estimated. This is a natural outcome of using a model-based approach as the predictions put less weight on outlying observations and so they appear to “shrink” towards the average level.

Nevertheless estimates can be used to make certain inferences, e.g. proportion of households in poverty in MSOA A is greater than the proportion of households in poverty in MSOA B (if the appropriate confidence intervals do not overlap).

### 2.2.3 Examples of data use

Given that model-based estimates are subject to limitations some examples of appropriate and inappropriate uses for the estimates are provided.

#### 2.2.3.1 MSOA comparisons

When comparing two model-based estimates, one MSOA may be said to have a significantly lower or higher poverty level than another if the confidence intervals for the two MSOAs do not overlap. For example, using Table 1 it may be said that MSOA C has a significantly lower model-based poverty estimate than MSOA A since the 95 per cent confidence intervals do not overlap. However, it would be incorrect to say that MSOA B has a significantly lower model-based poverty estimate than MSOA A, since the confidence intervals overlap.

**Table 1 Model based poverty estimates and confidence intervals for three MSOAs**

95% Confidence interval for the poverty estimate			
	Estimate	Lower Confidence Limit	Upper Confidence Limit
<b>MSOA A</b>	0.68	0.59	0.76
<b>MSOA B</b>	0.58	0.49	0.67
<b>MSOA C</b>	0.46	0.38	0.55

Source: Office for National Statistics

MSOA-level estimates can be aggregated to higher geographical levels. Table 2 provides model-based estimates of proportions of households in poverty for three LADs. Although the poverty estimate for LAD A may seem a great deal lower than that for LAD C, there are no confidence intervals available for geographies other than MSOAs. This means that we have no measure of the precision of the estimates and therefore cannot say that one aggregated model-based estimate is significantly different to another.

**Table 2 Aggregated model based poverty estimates for three local authorities**

	Estimate
<b>Local authority A</b>	0.12
<b>Local authority B</b>	0.20
<b>Local authority C</b>	0.35

Source: Office for National Statistics

### 2.2.3.2 MSOA profiles

The model-based MSOA estimates of poverty can be used in conjunction with other data sources to build up a profile of a particular MSOA. Examples are shown below in Table 3.

**Table 3 MSOA profiles**

	MSOA A	MSOA B	MSOA C
<b>Model based estimate of proportion of households in poverty with 95% confidence interval</b>	0.32 [0.25,0.41]	0.28 [0.2,0.38]	0.11 [0.08,0.16]
<b>% Adults claiming income support (2007)</b>	7%	23%	2%
<b>% Properties in Council Tax Band G and H (2007)</b>	10%	< 0.5%	31%
<b>Rank of local authority in which MSOA lies on the Index of Multiple Deprivation Income Domain (2007)</b>	Lower Quartile	Lower Quartile	Top 50%

Source: Office for National Statistics

## 3 Methodology overview

This section provides a brief description of the methodology for producing model-based estimates of proportion of households in poverty at MSOA level. A full description of the methodology can be obtained by request from the Area Based Analysis team in ONS: 'Better.Info@ons.gov.uk' or by accessing the associated Technical Report. For more information on the general small area estimation modelling procedure developed by the ONS, refer to the Small Area Estimation Project (SAEP) Report (Heady et al (2003)).

### 3.1 How do model-based estimates differ from standard survey estimates?

The principal reasoning behind the use of small area estimation is that surveys are designed to provide reliable estimates at national and sometimes regional levels but they are not typically designed to provide estimates for smaller geographical areas. The inevitable result is that for areas such as MSOAs is that the vast majority will contain no sample respondents at all and hence it is not possible to obtain direct survey estimates. In order to provide MSOA estimates of poverty using survey data (here the Households Below Average Income (HBAI) is used) a model-based approach has to be adopted. This methodology is dependent upon the correct specification of the model, the quality and relevance of the input data sources and the model fit.

The premise behind a model-based methodology is that we can find a relationship between the proportion of households whose net weekly income (after housing costs) is below £199, 60 per cent of UK median weekly income as measured by the HBAI, and other auxiliary sources of information (mainly provided from Census and administrative data) in the sampled MSOAs. We can then 'borrow strength' from this relationship to generalise and produce reliable estimates of proportion of households earning below £199 per week for *all* MSOAs (those covered in the sample and those not).

During our research, a number of different relationships and sources of information were investigated. The best sources of information available were selected for modelling. We are satisfied that while there are some limitations with our methodology (see Section 2) the models are well specified and the modelling assumptions hold.

### **3.2 Description of the data**

#### ***The survey data:***

The survey data used in this modelling exercise come from the HBAI datasets that are prepared by DWP using data from the 2007/8 Family Resources Survey (FRS) (Sullivan et al, 2009) . The FRS was chosen as the source for survey data for this study since it is the survey with the largest sample that includes appropriate and well validated questions on income.

#### ***The auxiliary data:***

The auxiliary data come from the following sources:

- Census, 2001
- DWP benefit claimant counts, August 2007
- Valuation Office Agency Council Tax Bandings, 2007
- Her Majesty's Revenue and Customs (HMRC), Child Tax Credit and Working Tax Credit, 2006
- Communities and Local Government (CLG), Change of ownership by dwelling price, 2007
- Regional/country indicators

### **3.3 Deriving the estimates**

To derive the required estimates of average weekly household income for MSOAs we:

- built a model relating the survey variable to the auxiliary information for MSOAs covered by the survey
- use the model and auxiliary data (which are available for all MSOAs) to estimate the proportion of households in poverty for all MSOAs
- ensure the model-based estimates are constrained to the HBAI poverty estimates at the GOR/country level. The model-based MSOA estimates of poverty were aggregated to GOR/country level and comparisons made between these aggregated estimates and the HBAI estimates at these levels. The relevant ratios of the HBAI estimates to the aggregated model-based estimates at the GOR/country level were then used to scale the model-based MSOA-level estimates

### 3.4 The model for households in poverty

Models have been developed for the purpose of producing small area estimates of proportion of households in poverty, for England and Wales. The models defined relate the HBAI survey estimate of proportion of households whose net weekly income (after housing costs) is below £199 to the following predictors:

- proportion of household reference persons aged 16-74 whose NS-SEC is managerial and professional
- proportion of household spaces that are detached, semi detached or terraced
- proportion of persons aged 16 to 59
- proportion of households that contain one person
- proportion of persons aged 16-74 that are full time students
- proportion of persons claiming Disability Living Allowance: Mobility Award Higher
- proportion of persons aged over 60 claiming Pension Credit: Guaranteed Element Only
- families out of work receiving Child Tax Credit
- the Government Office Region indicators

The model is used to estimate the proportion of households in poverty by MSOA.

### 3.5 Validation of the model

A number of diagnostic checks have been used to assess the appropriateness of the models developed for producing MSOA-level estimates of poverty. The analysis shows that in general the models are well specified and the assumptions are sound. This provides confidence in the accuracy of the estimates and the associated confidence intervals. In addition, the methodology used to produce the model-based estimates has undergone a review by Methodology Directorate. As well as validating the process of making the estimates it is necessary to validate the estimates themselves. Analysis to compare the model-based estimates with other sources of poverty data was carried out to establish the plausibility of the model-based estimates. These processes have ensured that the methodology and its application are valid, the models developed are the best possible for the data available and the model-based estimates are plausible. A fuller description of this work is available in a separate validation report published along with these estimates.

### 3.6 How precise are the estimates?

Each of the estimates is accompanied by a 95 per cent confidence interval. Confidence intervals provide a range for the proportion of households in poverty for each MSOA indicating the uncertainty or precision of each estimate. This uncertainty is a measure of potential departure for each MSOA from the fitted model; the confidence intervals indicate the ranges that for approximately 95 per cent of MSOAs will contain the true value.

## 4 Maps

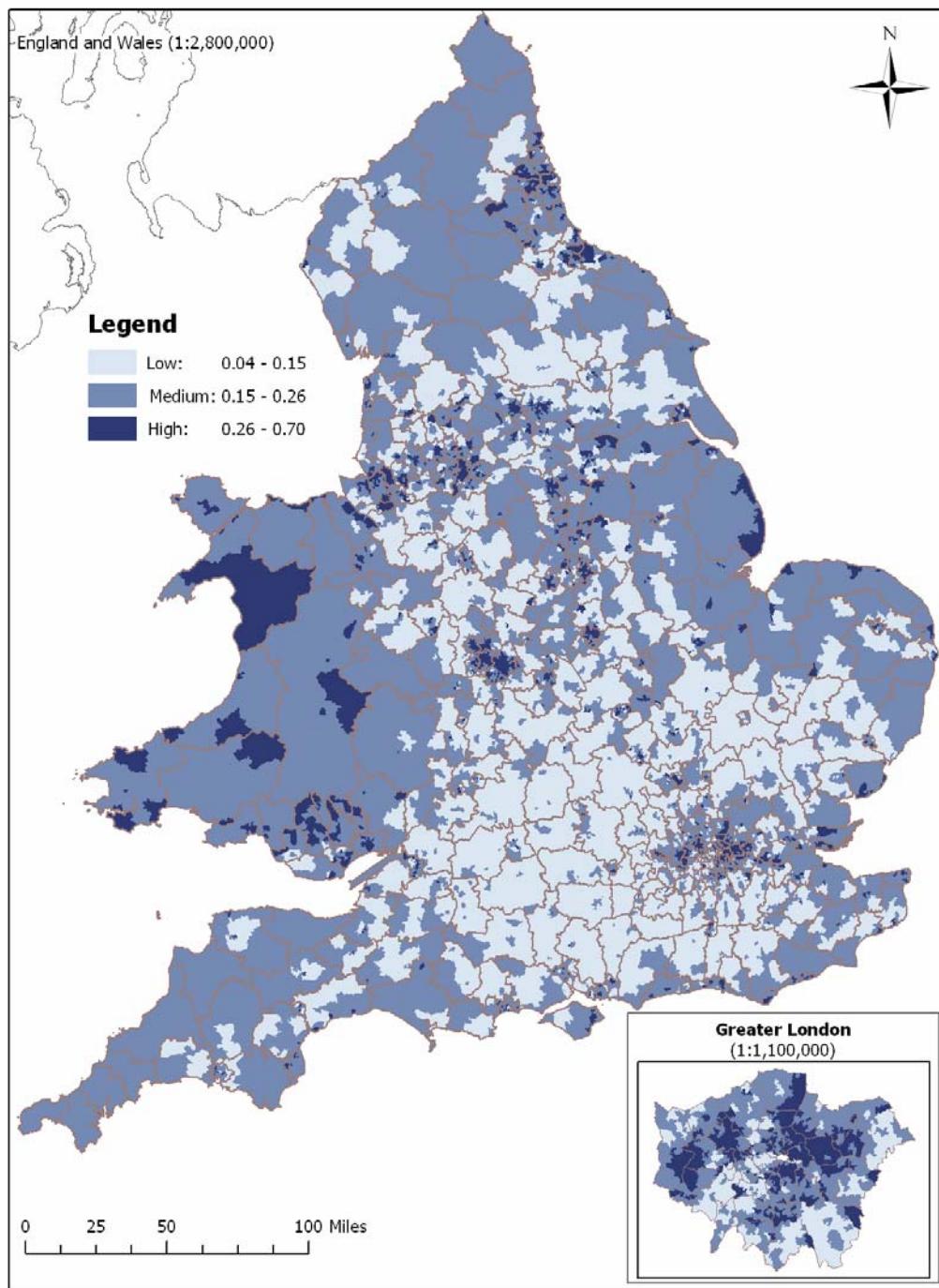
### 4.1 Introduction

The model-based MSOA-level estimates of proportion of households in poverty can be displayed on maps to show spatial patterns. The interval ranges in the map have been chosen to aid interpretation. 25 per cent of MSOAs are included in the ranges for the highest and lowest poverty levels and 50 per cent of MSOAs are included in the ranges for poverty levels nearest the average value. Section 4.2 shows the map of the estimates of proportion of households in poverty for England and Wales.

### 4.2 England and Wales

Map 1 shows the geographical variation of MSOA estimates of proportion of households in poverty for England and Wales. The map shows that the majority of MSOAs with the highest levels (darkest areas) of poverty are concentrated in London, North West and around the coasts of Yorkshire and The Humber and parts of Wales. As we move out further from these areas the average MSOA poverty decreases. Areas of lighter colour, i.e. lower poverty levels, are common in the South East, East, West Midlands and parts of the South West of England GORS. The 5 per cent of MSOAs with the very highest poverty levels are located in centres of major cities such as Birmingham, Liverpool and Manchester.

**Households with net equivalised (OECD) income (AHC) < 60% median  
2007-08 MSOA Estimates (calibrated)**



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## Appendix

### A Survey Data – income definitions

This appendix contains details on the income types modelled. For more specific information please refer to the survey reports (Sullivan et el (2009) and HBAI team (2009)).

#### Net household weekly income after housing costs (equivalised)

Net household weekly income after housing costs (equivalised) is composed of all the elements of net household weekly income but is subject to the following deductions prior to the modified OECD's equivalence scale being applied:

- rent (including housing benefit)
- water rates, community water charges and council water charges
- mortgage interest payments
- structural insurance premiums (for owner occupiers)
- ground rent and service charges

Applying the equivalence scale adjusts the household net income values to take into consideration the number and composition of people in the household; it represents the net income level of every individual in the household. Equivalence is needed in order to make sensible income comparisons between households. For example, one household may have 2 adults and 2 children and have a total weekly household net income of £300. If this is compared with a household containing just 1 adult who has a total weekly household net income of £270, then although the first household has the higher total weekly income it is the second that has the higher standard of living.

Although a number of equivalence scales have been developed, the equivalence scale used for the income estimates is the modified OECD's scale. An example of the effect of applying the modified OECD's scale is as follows:

A single person, a couple and a couple with two children aged four and seven, all have unequivalised net weekly household incomes of £100 after housing costs. After equivalisation, these become £172 (single person); £100 (couple); £71 (couple with two young children).

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